Accurate and reliable differential expansion measurements

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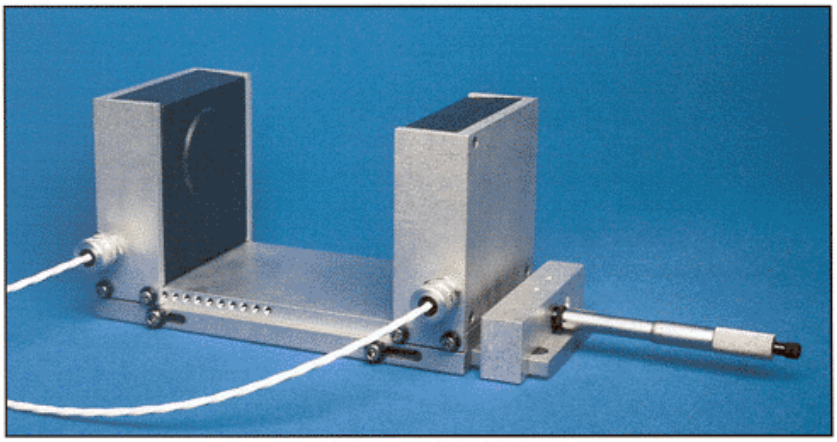
The 50 mm Differential Expansion (DE) Transducer has the *longest linear range* of any non-contacting transducer system produced by Bently Nevada to date. Its advanced electronics, gives it a linear range from 1.3 mm (0.05 inches) to 29.2 mm (1.15 inches). If mounted using the complementary input configuration described below, its maximum range doubles to 58.4 mm (2.3 inches). The 50 mm DE Transducer also provides you with superior accuracy, reliability, ease-of-installation, and verification. It is an excellent solution for measuring differential expansion on large steam turbines.

The 50 mm Differential Expansion Transducer is our most accurate and reliable transducer for proximity measurements where the maximum range exceeds 12.5 mm (0.49 in).

Differential expansion

Most steam turbines, especially large turbines, undergo differential expansion under transient conditions. Differential expansion is the change in axial position of the rotor relative to the casing, due to thermal expansion, which occurs primarily during machine startup and shutdown.

By closely monitoring the position of the rotor relative to the machine casing (at some distance from the thrust bearing), you can ensure that the difference in expansion rates between the rotor and the casing remains within specified limits. By incorporating differential expansion into an Emergency Shutdown System (ESS), you can significantly reduce or eliminate damage from axial rubs. Most Turbine Supervisory Instrumentation (TSI) systems include at least one differential expansion measurement.



50 mm Differential Expansion Transducer mounting bracket with probes in a complementary input configuration.

The two most common ways to measure differential expansion both use proximity transducers. In one system, the transducers observe a straight collar on the turbine rotor. In the other system, the transducers observe a ramp on the rotor.

The straight collar system uses one proximity transducer, mounted on the casing, to observe the axial movement of the collar. If the range of the differential expansion movement is greater than the range of the proximity probe, then two probes are installed in a Complementary Input for Differential Expansion (CIDE) configuration. In the CIDE configuration, two probes monitor the movement of one or two collars by facing the collar(s) in opposite directions (Figure 1). This doubles the measurement range since, as the collar extends beyond the range of one proximity probe, it moves into range of the other.

The other common differential expansion measurement uses two proximity probes, mounted to the case, to observe ramps machined into the rotor (Figure 2). The monitoring system converts the proximity probe range (measured perpendicular to the ramp surface) into an equivalent axial movement. Unlike the straight collar complementary input configuration, two transducers do not increase the measurement range. Axial movement of the rotor produces a signal which is opposite in polarity for the two proximity probe transducers. Radial movement of the rotor produces a signal of the same polarity for the two proximity probe transducers. By subtracting the signals from the two transducers to compensate for this radial movement, you can determine the magnitude of the differential expansion in the axial direction.

Improved installation and verification

During installation and maintenance overhauls, the correct operation of the transducer system should be verified and the appropriate gap (distance) set between the transducer and the target. The proximity transducer senses the distance between the probe tip and an observed surface. Eddy currents are generated in the target surface and a change in the strength of the return signal is detected by the transducers. Verification simulates the motion of the shaft collar.

It is accomplished by physically moving the transducers and recording outputs across the entire transducer range.

The probes must also be moved when setting the gap. When a probe is gapped, you adjust the distance between the probe and the observed surface to the distance you want the probe to be from the target under startup conditions.

Enhanced mounting

In the past, gapping and verifying differential expansion transducers has been difficult, especially for those used in a complementary input configuration. Most DE mounting brackets are fabricated so the bracket cannot be moved relative to the case. If the bracket which holds the DE transducers cannot move, the transducers must be either mechanically gapped in place or removed from the bracket and moved by hand. Both methods introduce errors in the verification and are time-consuming.

Improved mounting bracket

To solve problems associated with gapping and verifying DE transducers, Bently Nevada developed an *enhanced mounting bracket* for the 50 mm DE transducer. This optional bracket allows the transducers to move, so gapping and transducer verification is quick, easy, and accurate. The transducers mount on a bracket that slides on a stationary base. During operation, the sliding mounting bracket is secured to the stationary base to prevent movement. We designed brackets to use in three separate applications: a single transducer mounting, a complementary input configuration for viewing a straight collar, and a complementary input configuration viewing straight couplings.

Simplified Design

Most Bently Nevada eddy current transducer systems have separate electronics for the Proximitor® sensors and proximity probes. The new 50 mm DE Transducer system combines an eddy-current Proximitor® sensor and probe in one sensing unit. This more basic, integral design provides the following advantages:

- *Simpler installation.* You now need only one mount, since the Proximitor® sensor and the probe are now combined.
- *Fewer spare parts are required.* This design eliminates the need for a cable from the probe to the Proximitor® sensor. Therefore, fewer spare parts are necessary in your inventory.
- *Easier to troubleshoot.* Since there are fewer components and connections, it takes less time and effort to determine the root cause of a problem.

High accuracy

During the design of the 50 mm DE Transducer, we concentrated on increasing the accuracy of our differential expansion measurement. We reduced errors by 75% over our previous 50 mm Extended Range Transducer by introducing two major improvements:

- The standard new 50 mm Transducer is a matched system which is calibrated at the factory as a system. We eliminated the cable between the Proximitor® sensor and probe, and any errors normally introduced by this cable.
- A new *on-board temperature sensor* compensates the signal over the wide temperature range of 0° C to 120° C (32° F to 248° F). The compensated output provides more accurate differential expansion measurements throughout the operating temperature range.

Value for your investment

- The 50 mm DE Transducer maintains its full linear range for collar heights as low as 101.6 mm (4 in). It has a 25.4 mm (1 in) linear range on collars as low as 88.9 mm (3.5 in) without modifications. In most cases, we can modify the 50 mm DE Transducer or the monitoring system for use on collars as small as 63.5 mm (2.5 in) with a decrease in range.
- The transducer comes with a FluidLoc™ cable, which *inhibits oil from leaking* through the cable housing and out of the machine.
- A shield built into each transducer *reduces sideview* of the rotor surface.
- The 50 mm DE Transducer is a *cost-effective solution* for your differential expansion needs. Our improved 50mm DE Transducer sells for the same price as our previous 50 mm Extended Range Proximity System. With less expensive installation and verification costs, it provides a greater return on your investment.
- The 50 mm DE Transducer is *compatible* with our existing 7200, 3300, and 3500 Differential Expansion Monitors.
- After rigorous testing, the 50 mm DE Transducer was found to be compliant with Directive 89/336/EEC (EMC Directive) and received the *European CE Mark.*

For more information, contact your nearest Bently Nevada sales and service representative. ■

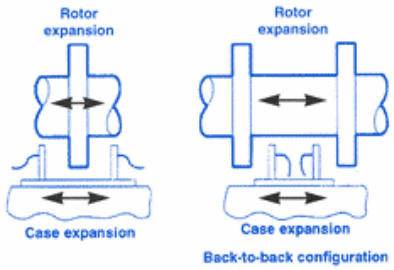


Figure 1
50 mm DE transducers in a Complementary Input for Differential Expansion (CIDE) application.

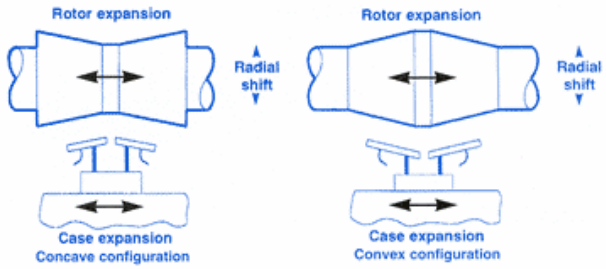


Figure 2
50 mm DE transducers in a ramp configuration.